Designing An Assistive Naming App for Mandarin-Speaking Anomic Aphasia Patients

by

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Abstract

This Major Research Project is motivated by my lived experiences with my grandfather, an anomic aphasia patient, who experienced embarrassment and frustration in his daily life due to lost ability to recollect names of things and people. Starting with a literature review of popular anomia apps and supported by a user persona built based on my grandfather's profile, I derived a "vocabulary database" in consultation with a speech-language pathologist, and designed a prototype mobile application *iRemember*, to assist anomic aphasia patients speaking Mandarin and English in recollecting names of daily life objects independently. The app affords searching its database for any real life object by taking a picture using the app and also to add items to the database with audio and text descriptions. The app offers service in Mandarin and English and will be useful to Chinese aphasia patients living in Canada or other English speaking regions who have lost one or both languages. Future work includes developing the prototype into a full-fledged app through a user-centered process, and enabling it in other languages.

Keywords: anomic aphasia, communication, vocabulary, mobile app, assistive technologies, augmentative and alternative communication

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Dedication

To: My grandfather - Zhongfa Lu

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Introduction

Communication is essential for living in this world. Yet, it is not uncommon to find people who are constrained by either cognitive or verbal communication disorders due to brain damage. One such condition, referred to as *anomic aphasia,* is a deficit of expressive language following brain injury, resulting in a consistent inability to recollect words for things.[1] More often than not, such conditions result in a state of dependence on others for performing activities of daily life. Such loss of agency could leave the individuals with a sense of lower self-esteem.

This project examined the case of Mandarin-speaking Chinese people living with anomic aphasia whose problem of word-finding is compounded by their inability to speak English, given that the few technological tools available for assisting anomic patients with word-finding are primarily in English. With the objective of helping such individuals reclaim their agency over activities of daily life and how they engage with others, a mobile app for assisted communication was designed in Mandarin to help them recollect names of things. In

[1] http://www.webmd.com/brain/aphasia-causes-symptoms-types-treatments, last accessed on March 25, 2016.

addition, this app also provides a vocabulary that is consistent with their culture.

1.1 The Problem of Anomia

Aphasia is a communication disorder resulting from damage or injury to parts of the brain connected with language, and is common in older adults, particularly those who have had a stroke[2]. The speech or language of a person with aphasia is significantly impaired in one or more of the four communication modalities – auditory comprehension, verbal expression, reading and writing, and functional communication (Damasio, 1992). Although Aphasia is an acquired communication disorder that impairs a person's ability to process language and to speak and understand others, it does not affect intelligence.[3]

The American Speech-Language-Hearing Association (ASHA) reports that there are approximately 1 million people in the United States and 250,000 people in Great Britain with aphasia and nearly 80,000 new cases are reported each year[4]. Aphasia is more common

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[2] Stroke occurs when poor blood flow to the brain results in cell death. A stroke can cause lasting brain damage, long-term disability, or even death. (http://www.nhlbi.nih.gov/health/health-topics/topics/stroke)

[3] http://www.aphasia.org last accessed on March 25, 2016.
[4] http://www.asha.org/public/speech/disorders/Aphasia, last accessed on March 25, 2016.

than Parkinson's Disease[5], cerebral palsy[6] or muscular dystrophy[7]. Yet, surprisingly, most people have not heard about it[8]. Fifteen percent of individuals under the age of 65 experience aphasia; this percentage increases to 43% for individuals 85 years of age and older (Engelter et al., 2006).

According to the National Aphasia Association, there are different forms of aphasia such as anomic, mixed non-fluent, and global; of these, anomic aphasia (also referred to as *anomia*) is one of the milder forms of aphasia[9]. Anomia can be caused by either a congenital condition, or by brain trauma, such as accident, stroke, tumour, head trauma, dementia[10], and aging[11]. The term is applied to people who experience a persistent inability to supply the words for very things they want to talk about.

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[5] Parkinson's Disease is a degenerative disorder that affects nerve cells in the brain causing muscle rigidity, tremors, and changes in speech and gait. (http://www.webmd.com/parkinsons-disease/default.htm)

[6] Cerebral palsy denotes a group of chronic disorders that impair control of movement due to damage to the developing brain. (http://www.webmd.com/brain/understanding-cerebral-palsy-basic-information)

[7] Muscular dystrophy is a group of genetic diseases in which the muscles that control movement progressively weaken. (http://www.webmd.com/children/muscular-dystrophy-directory)

[8] http://www.aphasia.org/aphasia-faqs last accessed on March 25, 2016.

[9] http://www.aphasia.org/wp-content/uploads/2014/12/Aphasia-Definitions.pdf last accessed on March 25, 2016.

[10] Dementia is a broad category of brain diseases that cause a long term and often gradual decrease in the ability to think and remember; it could affect a person's daily functioning. (https://www.nlm.nih.gov/medlineplus/dementia.html)

[11] http://www.webmd.com/brain/aphasia-causes-symptoms-types-treatments last accessed on March 25, 2016.

People with anomia are often fluent and grammatically correct and yet have a problem in recalling names, numbers, colors and places. As a consequence, they tend to exhibit circumlocution (speaking in a roundabout way) in order to avoid a name they cannot recall or to express a certain word they cannot remember. Sometimes they know what to do with an object, but still are not able to recall the name or the color. This not only makes it difficult for them to get things done but also causes considerable social embarrassment, leading to lower self-esteem.

1.2 Rationale for a New Word-Finding App

My personal interest in this project stems from the fact that I have witnessed my grandfather struggling to communicate due to anomia for over 20 years. He was diagnosed with anomic aphasia in 1995 following a severe car accident. Circumlocution is a common strategy he uses when having trouble with word finding. However, extensive circumlocution sometimes makes his dialogue very difficult to follow and understand. With my grandfather, I have seen how rough a consistent conversation could be for an anomia patient. I am told that there is no way for his brain damage to reverse. A digital assisstive communication tool might, however, help him access the names of objects when he is unable to find the words. Research of

Chinese literature showed no mention of such tools of daily use in China.

There are apps in the western market such as iName It[12] that are used by Speech Language Pathologists (SLPs) and family members in assisting anomic patients recall names of common items found in homes. However, these apps are available only in English and contain vocabulary culturally and linguistically specific to a western population. My grandfather would not be able to use these apps as he knows only Mandarin and his vocabulary of daily usage is different from that of a typical person living in the western world. There is thus a need for stretching the design of existing naming apps to fit his needs and that of others with his profile.

1.3 Design Challenge and Outcome

The principles of inclusive design relating to inclusive models[13] suggest the consideration of requirements of one or more edge case users in a given context or contexts while creating a design for a currently underserved user group. In case co-design with them is not possible, their requirements could be included in the generative phase or evaluative phase or both of a user-centered design cycle. The

[12] http://smartyearsapps.com/service/iname last accessed on March 25, 2016.
[13] https://wiki.gpii.net/w/Use_model last accessed on March 31, 2016.

underserved user group in my case is elderly, Mandarin speaking, Chinese anomia patients in the context of achieving assisted communication through mobile naming apps. I undertook this project as a design challenge involving the inclusive design of a mobile naming app for this group considering my grandfather as an edge case user.

By providing the details about my grandfather, who lives in China, to a Speech Language Pathologist working with Mandarin speaking anomic patients in Toronto, I derived a culturally sensitive vocabulary for the app. Grounded in the principles of inclusive design learned through the program, and supported by my mobile application design and development skills, I designed a prototype mobile naming app called *iRemember* based on this vocabulary. Plans for an iterative user-centered evaluation of the prototype and development of the app are included in future work. When developed into a working app, I believe that the iRemember app would augment the communication of anomic users such as my grandfather.

Using a hierarchical database of daily living items, the app will prompt the user with the names of commonly used things numbers, colors and places that they are unable to recall. The user would also be able to retrieve the name and description in Mandarin and English of any item around them in real life by using the inbuilt camera to take a

picture of it through the app. Internally, the app will first compare the picture with the available database of pictures and corresponding descriptions created previously. If a match cannot be found there, the picture will be forwarded to a pre-defined community for crowdsourcing the name and description. The item will then be added to the database.

1.4 Methodology Adopted

This project used an inclusive design approach to design an assistive tool for anomic aphasia, in that it attempted to stretch the design of anomia word-finding apps (that currently cater primarily to English speaking western population) to include an edge case user (Mandarin speaking senior). The various phases of the project were:

- Generation of requirements through:
    - a review of literature
    - my reflections of my experiences with my grandfather
    - critical evaluation of some apps in the market
- Creation of a vocabulary database of pictures and names of culturally specific things, numbers, colors and places useful in daily life to Mandarin speaking seniors through consultation with a Speech Language Pathologist in Toronto

- Design of a prototype app to support Mandarin speaking anomic aphasia patients living in Toronto in their daily communication

The goal for designing a new assistive naming app would be to reduce the daily perplexity and embarrassment in the lives of Mandarin speaking Chinese anomia patients. The app cannot provide any treatment or cure for anomia.

1.5 Report Outline

This introductory section is followed by a review, in section 2, of relevant previous research on Anomic Aphasia around three themes– the pervasive problem of word finding, selective language recovery following bilingual aphasia; and special needs of children with anomia, to identify some general criteria for the app design. Section 3 presents a user persona of the edge case user derived from my lived experience with my grandfather who has been leading a life of daily complexity, embarrassment and frustration with anomia for over 20 years. Section 4 reviews popular apps related to anomia therapy, pattern recognition and image retrieval in the context of the requirements of the edge case user. Derivation of a vocabulary database in consultation with a Speech Language Therapist to meet the profiled user's daily life needs is dealt with in Section 5. In Section 6, a visual representation of the

process flow of the *iRemember* app and mockups of the user interface screens are presented and explained. Section 7 describes hypothetical use case scenarios about how some goals of the user persona of a senior, Mandarin speaking, anomia patient described in Section 3 could be met using some of the features the *iRemember* app. Section 8 presents the unique contributions of the study and its implications to the field of inclusive design, followed by a brief discussion of the limitations and future steps in the work.

2 More About Anomia

2.1 Introduction

This section presents a brief history of the medical condition of anomia, to set the stage, followed by a discussion of three significant aspects relating to different types of anomia patients: (i) the need for agency in managing the pervasive problem of word-finding in anomia, (ii) the situation of selective language recovery following bilingual aphasia, and (iii) some special needs experienced by children with anomia that could benefit all ages. From this discussion, certain general criteria are drawn at the end for consideration in the design of the app.

2.2 Brief History

Prior to the 18th century, speech disorders were not associated with language or its relation to the brain. Three forms of speech disorder were distinguished–*traulotes, psellotes and ischophonia*; but these have only a marginal relationship to aphasia (Eling & Whitaker, 2009). In the second half of the 19th century, Broca and Wernicke described the two classical forms of aphasia that now bear their names. About 100 years later, Benton and Joynt (1960) presented a historical overview of the literature on aphasia from the Hippocratic writings. Since this seminal review, there has been a growing interest in the

history of aphasiology, resulting in many papers and books about hitherto unknown writings about aphasia (Prins & Bastiaanse, 2006).

Aphasia is an acquired language disorder that significantly affects the daily lives of survivors and their family members. It creates negative consequences for social, vocational, and recreational activities. Often, it leads to social isolation, loneliness, restricted activities, role changes, loss of autonomy, and stigmatization (Simmons-Mackie et al, 2010).

2.3 Word Finding – a Pervasive Problem

Due to multiple types, symptoms, needs and problems of the disease, the literature examined were seen to have different foci. Even so, the problem of *word finding* was seen as the most pervasive and severe symptom and deficit in aphasia, as elaborated below. This is also termed as anomic aphasia, or simply anomia.

Anomia patients have consistent inability to produce words for things that they want to talk about. Problems particularly centre on nouns, such as names, colors, places and so on. Sometimes, patients know what to do with the object, but are not able to recall the name or color. Normally, anomia does not include obstruction of cognition and a drop in intelligence; nor does it include damage of visual sense, auditory sense, vocal sense, writing or reading. Patients are often

relatively fluent and grammatically correct. These are the reasons why they tend to use circumlocutions (speaking in a roundabout way) in order to avoid a name they cannot recall or to express a certain word they cannot remember.

According to Boston Diagnostic Aphasia Examination (BDAE, 1998), anomic aphasia exhibit different extents. There are six levels. Patients who are at the highest level do not have the ability to speak, listen, understand, write or read at all. On the contrary, people at the lowest end, cannot be perceived as anomic by listeners.

There is no method available to completely cure anomic aphasia. However, there are treatments to help improve word-finding skills. Most common therapies include Visual Therapy (Coelho, McHugh & Boyle, 2000), Circumlocution Induced Naming therapy (CIN) (Francis, Clarke & Humphreys, 2002), Computer-Assisted Therapy (CAT) (Leemann, Laganaro, Chetelat-Mabillard & Schnider, 2010), excitatory (anodal) transcranial direct current stimulation (Flöel et al, 2011). A few others as described on aphasia.org are[14]: Constraint-Induced therapy (CIT), Melodic Intonation Therapy (MIT), Tele-

[14] http://www.aphasia.org/aphasia-resources/aphasia-therapy-guide last accessed on March 27, 2016.

rehabilitation, PACE therapy (Promoting Aphasics' Communicative Effectiveness), Conversational coaching and Supported conversation.

Most of the therapies and family assistance techniques require human interaction and communication. Since therapy and medicines appear to be the only ways to improve anomic aphasia patients' "word-finding" skill, extra assistance is essential to make the lives of the patients, their family members, and the therapists easier and less frustrating. If such assistance could be obtained directly online or if there was a readable, audible and editable accessible tool that could help, that could help a larger proportion of anomia patients. An accessible tool that patients can use by themselves during the recovery therapy phase and through their lives would be helpful in making them feel independent.

2.4 Selective Language Recovery

Bilingual anomia has been drawing the attention of researchers for the last decade. Bilinguals, that is, people who speak more than one language, are known to recover from aphasia in a number of different ways. The most common case is when the bilingual patient similarly recovers both languages equally well as in parallel aphasia. In some cases, however, the recovery of bilingual is disproportionately

favouring one of their languages and this type of recovery is called selective aphasia (Dimitrova & Hulten, 2015).

The case of selective aphasia made researchers initially believe that each language of a bilingual person must be located in a different brain area, given that one language recovers better than the other after the stroke. However, with the help of brain imaging scans it is now know that, on the contrary, when a person speaks many languages, they all activate a common network of brain areas (Dimitrova & Hulten, 2015).

One of the current theories on why bilingual aphasics may disproportionately recover one language better than the other suggests that this happens when the stroke damages specific control mechanisms in the brain. When a bilingual person knows two languages, they need to suppress or 'switch off' one of the languages while using the other language. If the mechanisms that control this switch are damaged during the stroke, the aphasic patient may no longer be able to similarly recover both languages as the ability to control the language use has been lost. In this case the person may appear to have completely lost one of the languages, but the problem is actually one of control. Recently researchers found that the control mechanisms are more impaired in bilinguals with selective aphasia

who recover only one language than in bilinguals with parallel aphasia who recover both languages (Dimitrova & Hulten, 2015).

There is controversy over the separateness of the two languages in the brain and the mechanisms for accessing their lexicons (Perani, Paulesu, Galles, et al, 1998). These two mainstream theories are presented below.

1. If a person is less proficient in one of the two languages, this language may not recover as good as the more proficient language. This means that the more automatic a skill is, the easier it is to recover it, whereas something that takes effort such as language that one only speaks rarely is harder to recover. Social factors and emotional involvement are also important if we want to understand which language will recover after a stroke, for instance how often a specific language is used, or what emotions are associated with a specific language. However, it is still unclear exactly how these factors interplay in predicting the recovery success (Dimitrova & Hulten, 2015).

2. This is Dr. Mario F. Mendez's case report. A 71-year-old man had the acute onset of word-finding difficulty in English. The patient was bilingual and spoke Spanish exclusively until age 7, when he began school entirely in English. His entire education was in English,

and this became his strongest language, both at work and at home. On initial examination, he had a Wernicke's aphasia in both languages and a right pronator drift with brisk reflexes on the right. The patient was diagnosed with an acute left hemisphere stroke at the junction of the left middle cerebral and posterior cerebral arteries. Twenty days after his stroke, the patient complained of residual word-finding difficulty in English but not in Spanish. He had resorted to borrowing words from Spanish in order to express himself in English. In conversational speech, Spanish names frequently intruded into his normal English discourse. The patient estimated that prior to his stroke, his fluency in Spanish was fair and in English was excellent. After his stroke, he described his fluency as reversed, that is, better in Spanish than in English (Mendez, 2000).

In summary, bilingual anomia patients typically experience anomia to a greater degree in just one of their fluent languages (Mendez, 2001), and they may disproportionately recover one language better than the other, or may only recover one language (Dimitrova & Hulten, 2015).

From this discussion, it is clear that applications that support anomia must support languages other than English even with populations that are primarily English speaking. Multi-language assistance thus comes up as a requirement for the design of apps for

anomic individuals. Current popular apps are available only in English or Spanish or French.

2.5 Anomia in Children – Special Needs

Anomia in children is a very special and sensitive subject. For children who have congenital anomia, many vocabularies, items and definitions have never registered in their brains, not to mention recovering those words. Unlike adults, children may be born with a significant compromise of the brain mechanisms responsible for language. A large number of congenital conditions affect language (Dennis, 2011). For children who acquired anomia after a period of language learning, the capacity of vocabularies in their brains is also limited. Like adults, children can exhibit language disorders from injury to the central nervous system after a period of normal development. Childhood-acquired language disorder, or childhood-acquired aphasia, refers to language impairment evident after a period of normal language acquisition that is precipitated by, or associated with, an identified form of brain insult (Dennis, 2011).

Broadly, semantics is concerned with meaning. Semantic disorders in children with brain injury range from severe verbal auditory agnosia for common sounds, such as a dog barking or a doorbell ringing (Cooper & Ferry, 1978), to problems understanding

word meaning (Dennis, 1992) or oral or written texts (Barnes, Faulkner, Wilkinson, & Dennis, 2004).

The segmental aspect of phonology and speech processing involves phonological perception and integration (Plante, Holland, & Schmithorst, 2006) of features such as vowels, consonants, and syllables that have direct, identifying relationships with utterances (Crystal, 1973). The nonsegmental aspect of phonology concerns a range of features, loosely referred to as "tone of voice," that include intonation, stress, rhythm, and speed of speaking and that have a variable relation to the segmental, verbal aspects of utterances (Crystal, 1973).

Morphology is critical to the production of complex words (Jarema, 2008), and components of the language production system are important for producing free-standing function words and inflectional morphemes in words and sentences. These morphological components are different from vocabulary words because they do not bear nonemphatic stress in derived words or sentence structures, and they do not follow regular word formation processes. The speech of adult aphasic patients with anterior lesions is often agrammatic, with a breakdown of sentence structure and the omission or misuse of grammatical morphemes, even while access to content words, such as

verbs and nouns, is relatively unimpaired. In adults, a disturbance affecting the production of inflections and derivational morphemes has been termed *agrammatism* or *paragrammatism*, and the characteristic is the omission or substitution of function words and affixes (Menn, Obler, & Goodglass, 1990).

Moreover, research on children with anomia has indicated that children who undergo treatment are, for the most part, able to regain normal language abilities, aided by brain plasticity. However, longitudinal research on children with anomic aphasia due to head injury shows that even several years after the injury, some signs of deficient word retrieval are still observed, which could sometimes cause academic difficulties later on (Van Hout, 1992).

Due to the limited language capacity as well as semantic, phonological and morphological disability that children with anomia have, vocal auditory and dynamic video assistance would be quite helpful to them. Besides, audio description could be useful to anomia patients with visual impairments as well.

2.6 Some Design Considerations

Anomia patients have a severe difficulty in locating the right word in their brains. And there is no effective solution that can completely cure anomia at this moment. This symptom directly leads to the

compounding of isolation, loneliness, social embarrassment and stigmatization during the daily life interaction and communication between the patient and his/her family members. Assistive tools that they could use and manage *independently* would help them recover more gracefully.

Predominantly, individuals with bilingual anomia are only able to recover one language. It is thus possible that, where a patient was primarily English speaking prior to the illness, he is able to recover his second language but not English. This emphasizes the need for creating apps that are multilingual.

Examination of the case of children with anomia alerts us to the fact that for patients with limited language capacity as well as semantic, phonological and morphological disability similar to what children with anomia have, it might be helpful to provide vocal auditory cues and dynamic video assistance. Audio descriptions could be useful to anomia patients with visual impairments as well.

The next section is devoted to deriving a user profile that will drive further exploration of currently popular apps in section 4 to derive requirements for the design of an assistive app for Mandarin speaking Chinese anomic patients. Insights gathered above from a review of literature will also be included in the design.

3 Profiling the User

3.1 Motivation

Why did I decide to do this research? Or, what triggered me to purpose a design for this specific health problem? The answer is my grandfather. He is an aphasia patient who has been living with this disease for over 20 years. I have seen how rough a consistent conversation could be for him. Circumlocution is a common strategy used by individuals when they are having troubles with word finding. However, extensive circumlocution can make an individual's dialogue very difficult to follow and understand. This could result in their leading a life of daily complexity, embarrassment and frustration with anomia. In this, I present my own experience with my grandfather over the past couple of decades to provide a sense of life with this health condition.

3.2 My Grandfather's Story

My grandfather acquired aphasia due to a severe road accident twenty-three years ago. Ironically, I was with him during the accident–I was three years old then–but nothing happened to me. My grandfather was riding a bike through the front gate of his company and on to the road and I was sitting on the back seat. More ironically, he just retired that day. It was his last day at work in the company he

had been with for over forty years. We were going home to celebrate with the rest of our family. In the meantime, a speeding motorcycle came out of the blue and hit us. My grandfather fell to the ground; there was blood all over his body. But, I was perfectly fine. Honestly, I still do not know whether the motorcycle driver did not see us or my grandfather did not see him. But, that is besides the point of our story.

During the surgery, half of my grandfather's brain was resected. Many might wonder how he could still be alive. Well, I am not a neurologist. If they could make him live with half of his brain, I guess he just can. He was taken home after two full years of observation in the hospital.

3.3 Tip of The Tongue

Because my grandfather was in his early sixty's when he had the surgery, he could still do everything independently except for talking "sensibly". He knew how to peal the skin of an orange, he knew how to turn on the TV, he knew how to open a bottle of wine, he knew he was supposed to sleep on a bed, he knew he was supposed to sit on a chair and not on the ground. But, he could not name what these objects were. An example will illustrate this.

I remember one time he was asking an orange from my grandmother. This is how he said it, "Um… Um… I… want… I… Um…

I… I… I… the… rounded… eat… delicious… I… that… Um… rounded…" Apparently, no one understood him. The interesting point is he could tell that we did not understand, because aphasia does not result in cognitive impairment. So, he started using hand gestures. He used both of his hands to make a circle, and imitated the motion of pealing an orange. Then we realized that he was asking for an orange.

Another symptom of his anomia is that he calls everybody the same name – my father's name. Literally, the "everybody" here refers to every person in his life. I thought he was teasing me the very first time I heard him say that. I was the first one to walk into the room. He called me by my father's name. Then my uncle walked in, and my grandfather called him too by my father's name. He even called my grandmother by my father's name. The moment I realized that he was not teasing, I felt really sad. Obviously, my father's siblings got jealous! They began saying that my grandfather only loved my father.

Sometimes, he even calls other items such as a table, a chair or a couch by my father's name if he is desperate enough. At the onset of aphasia, when my grandfather was in his early sixty's, he could still use verb and adjectives. But, as he continues to grow older with the passage of time, he is unable to even express verbs and adjectives correctly, especially during recent years.

3.4 Role of an Assisted Communication Tool

Based on the story I presented about my grandfather, you can clearly see that the cognitive functions of anomic aphasia patients are not affected. It is apparent that the space in the brain used to store and register nouns is somehow malfunctioning or damaged. Because they are not lacking intelligence, the poor word-finding situation really brings them unnecessary embarrassment, perplexity, confusion and chaos everyday. More importantly, as was seen in the literature review presented in Section 2, this is not a disease that can be cured. Not because the technology is not sophisticated enough yet, but because that part of the brain has already been damaged, and there is nothing neurologists can do.

Specifically for Chinese aphasia patients who are bilingual in Mandarin and English, loss of one of the languages might lead to greater cognitive load. This might also lead to language challenges and confusion far greater than for those knowing only one language. Code switching between the two languages might get harder, and make the person feel, "What is wrong with me?" Especially when they are living in a different environment where a language totally strange to their own is spoken, and there is word confusion in moving back to their own language.

Circumlocution is a good way to remit this condition, but it is also the "only" way, and it is a no-alternative way. This is quite sad. That is why therapy is the only remedial assistance that speech language institutions can offer now. Mostly, anomia patients seek the assistance of people to manage their communication, or lack of it, and this causes them frustration, perplexity and embarrassment on a daily basis. Therefore, it would be great if there is an accessible, assistive, inclusive and handy tool that can assist them with word-finding and, thereby, help them remain independent and self-sufficient. Which connects to my project's goal.

While several apps are available for anomic aphasia therapy, none of them support the Chinese language speaker and reader. So, what happens to Chinese anomia patients is that their family members are the only people they can rely on to seek help from. In most cases, this results in the loss of their independence. When the *iRemember* app is developed and released bilingually in Mandarin and English, I hope that it will help Chinese anomic aphasia patients living both in the eastern and western countries regain agency over their lives.

3.5 User Persona

Based on details from my grandfather's life, I present below a user persona to guide the app I am designing.

Zhongfa Lu: Mandarin speaking Anomic aphasia patient

"I want to call people by their correct names."

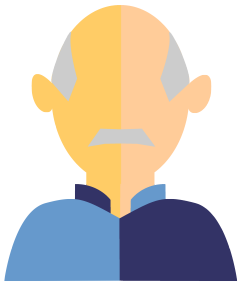

Figure 1: Profile picture of Zhongfa Lu

Zhongfa worked for 45 years in the Tax Revenue department in China and retired in 1995, at the age of 65. With a college degree in Chinese literature, he was proficient in spoken and written Mandarin. Soon after retirement, Zhongfa had a severe road accident that resulted in brain surgery.

Being still in his early sixty's, he still could do everything independently except for talking "sensibly". He knew how to peal the skin of an orange, he knew how to turn on the TV, he knew how to open a bottle of wine, he knew he was supposed to sleep on a bed, he knew he was supposed to sit on a chair and not on the ground. But, he could not name what these objects were. Another severe symptom of his anomia is that he calls everybody by the same name – his son's

name. Sometimes, he calls other items such as a table, a chair or a couch his son's name if he is desperate enough.

1. **Key characteristics:**

   Senior.

   Mandarin speaking.

   Is unable to name things.

   Is unable to have a consistent conversation.

   Wants to communicate with others.

   Wants to live like a normal person.

   Wants to interact with others without assistance.

   Is aware of his condition and feels bad about it.

2. **Frustrations:**

   Inability to recall names of things.

   Inability to address people by their correct names.

   Inconsistent conversations.

   Situations of daily perplexity and embarrassment.

1. **Goals:**

   Dreams of having an accessible and inclusive naming tool that can help him to reduce the frustrations. Specifically, offers Mandarin version, easy access, readable and listenable script, description and the ability to tell users the name of the item in pictures instantly.

Is looking for an alternative portable space to store the names and information of items such as family member, pets, and personal stuff, instead of writing everything down on a pile of papers, which are attached with a stack of photos.

2. **Challenge:**

   Using smart phones might be a bit hard for a senior like him. It might take a bit longer for him to get used to use all the functions smoothly.

4 Scan of Popular Apps

There are two Subsections in this Section. The first presents a review significant features of popular mobile apps available online for anomia patients keeping in mind the profile of the target user and their requirements. The second Subsection reviews pattern recognition apps. The Section closes with a summary of features for further consideration in the design of the prototype app iRemember.

4.1 Anomic Aphasia Therapy Apps

There are a number of apps available online for use in the therapy of anomic aphasia patients. Of these, some apps from three popular companies, Tactus Therapy Solutions, Smart Ears Apps and NeuroHero, which are relevant to the word-finding app design objective of this project, are reviewed below.

Tactus Therapy Solutions[15] is a Canadian company that offers multiple apps for people with aphasia and other communication disorders to enable speech, language, and cognitive rehabilitation. These apps are directed at both speech professionals and family members of patients. Some of the apps offered by them are:

[15] http://tactustherapy.com/apps last accessed on March 26, 2016.

language therapy, question therapy, conversation therapy, apraxia therapy, number therapy, spaced retrieval therapy, category therapy, dysphasia therapy, visual attention therapy, reading therapy, comprehension therapy, naming therapy, writing therapy, asking therapy and answering therapy. Amongst these, four apps that relate to aphasia patients–number therapy, category therapy, comprehension therapy and naming therapy–are examined below. Each app is presented in terms of features that could be adopted in the design of the prototype or need to be adapted to suit the needs of the target user for this project.

4.1.1 Number Therapy App

The Number Therapy app[16] helps people with aphasia practice communicating numbers of all sorts.

Table 1: Review of Number Therapy App

Sl no.	**Positive features**	**Relevance to target user**
1	Literal and verbal names provided	Helpful in remembering numbers
2	Different levels: understanding, speaking, typing	Helpful across range of abilities
3	Built in cues	Helpful for triggering memory
4	Can email results to therapist	Useful for therapy apps
Sl no.	**Negative features**	**Relevance to target user**
1	Numbers are too limited	Restrictive range of inputs

[16] http://tactustherapy.com/app/number last accessed on March 26, 2016.

2	Can not provide information about images	Not useful in recognizing images from real life.
3	Treatment tool; does not provide the names directly	Would not allow independent use
4	It is priced	Might not be affordable by all seniors

4.1.2 Category Therapy App

The Category Therapy app [17] helps individuals, who have experienced language loss due to stroke or brain injury, practice mental organization skills.

Table 2: Review of Category Therapy App

Sl no.	**Positive features**	**Relevance to target user**
1	Literal and verbal names provided	Helpful in remembering categories
2	Different levels: It has easy, medium and hard 3 different levels	Helpful across range of abilities
3	Many categories	Helpful for distinguishing categories
4	Different exercise methods	Helpful for consolidating memories
5	Can email results to therapist	Useful for therapy apps
Sl no.	**Negative features**	**Relevance to target user**
1	Categories are too limited	Restrictive range of inputs
2	Can not provide information about images	Not useful in recognizing images from real life.
3	Treatment tool; does not provide the names directly	Would not allow independent use
4	It is not free	Might not be affordable by all seniors

[17] http://tactustherapy.com/app/category last accessed on March 26, 2016.

4.1.3 Comprehension Therapy App

The Comprehension Therapy app[18] helps people with language deficits understand common nouns, verbs, and adjectives they hear or read.

Table 3: Review of Comprehension Therapy App

Sl no.	**Positive features**	**Relevance to target user**
1	Literal and verbal names provided	Helpful in remembering categories
2	Different levels: 3 levels of difficulty with automatic adjustments	Helpful across range of abilities
3	Built-in data collection	Useful for checking progress
4	Add photos and words	Helpful for self-customizing
5	Different language options	Inclusive for global use
Sl no.	**Negative features**	**Relevance to target user**
1	Words are too limited	Restrictive range of inputs
2	Can not provide information about images	Not useful in recognizing images from real life.
3	Treatment tool; does not provide the names directly	Would not allow independent use
4	It is not free	Might not be affordable by all seniors

4.1.4 Naming Therapy App

The Naming Therapy app[19] helps people who can't find the right words to learn strategies to communicate their thoughts or needs.

[18] http://tactustherapy.com/app/comprehension last accessed on March 26, 2016.
[19] http://tactustherapy.com/app/naming last accessed on March 26, 2016.

Table 4: Review of Naming Therapy App

Sl no.	**Positive features**	**Relevance to target user**
1	Literal and verbal names provided	Helpful in remembering categories
2	Four different activities	Helpful across range of abilities
3	Customizable contents	Flexible for editing contents
4	Different language options	Inclusive for global use
Sl no.	**Negative features**	**Relevance to target user**
1	Words are too limited	Restrictive range of inputs
2	Can not provide information about images	Not useful in recognizing images from real life.
3	Treatment tool; does not provide the names directly	Would not allow independent use
4	It is not free	Might not be affordable by all seniors

Smarty Ears is another company that produces apps geared towards speech therapy for mobile devices. Two apps from their offerings, language-trainer and iname, are examined below.

4.1.5 Language Trainer App

The Language Trainer app[20] helps individuals improve their mastery of spoken language.

Table 5: Review of Language Trainer App

Sl no.	**Positive features**	**Relevance to target user**
1	Literal and verbal names provided	Helpful in remembering categories

[20] http://smartyearsapps.com/service/language-trainer last accessed on March 26, 2016.

2	Four different activities	Helpful across range of abilities
3	Built-in data collection	Useful for checking progress
4	Customizable difficulty level	Helpful across range of abilities
Sl no.	**Negative features**	**Relevance to target user**
1	Images are too limited	Restrictive range of inputs
2	Can not provide information about images	Not useful in recognizing images from real life.
3	Treatment tool; does not provide the names directly	Would not allow independent use
4	It is not free	Might not be affordable by all seniors
5	Only available on iPad	Some users might not have iPads

4.1.6 iName It App

iName it Household Items app[21] is specifically designed to help individuals with difficulty recalling the names of common items found in the home.

Table 6: Review of iName It App

Sl no.	**Positive features**	**Relevance to target user**
1	Literal and verbal names provided	Helpful in remembering categories
2	Five different levels	Helpful across range of abilities
Sl no.	**Negative features**	**Relevance to target user**
1	Can not provide information about images	Not useful in recognizing images from real life.
2	Treatment tool; does not provide the names directly	Would not allow independent use
3	It is not free	Might not be affordable by all seniors

[21] http://smartyearsapps.com/service/iname last accessed on March 26, 2016.

4.1.7 Talk Around It App

The Talk Around It app[22] is designed for people with word finding problems that might arise from aphasia, dementia, stroke, autism and other conditions.

Talk Around it has five different version, they are household object words, common words about men, common words about women, nature words and common personal object words.

Table 7: Review of Talk Around It App

Sl no.	**Positive features**	**Relevance to target user**
1	Written and audio cues	Helpful in triggering memories
2	Following test	Helpful for examining the results
3	Progress diagrams	Useful for checking progress
Sl no.	**Negative features**	**Relevance to target user**
1	Images are too limited	Restrictive range of inputs
2	Can not provide information about images	Not useful in recognizing images from real life.
3	Treatment tool; does not provide the names directly	Would not allow independent use
4	It is not free	Might not be affordable by all seniors

[22] http://www.neurohero.com/apps_for_aphasia last accessed on March 26, 2016.

4.1.8 Constant Therapy App

Constant Therapy [23] is a suite of 60-plus dynamic therapy modules (60,000 exercises and growing) targeting speech, language and cognitive skills. The exercises include color photographs (not pictographs) and voice recordings.

Table 8: Review of Constant Therapy App

Sl no.	**Positive features**	**Relevance to target user**
1	A growing library of task categories and over 12000 exercises	Helpful in consolidating memories
2	Different levels	Helpful across range of abilities
3	Visual results	Helpful for therapist to track the results
Sl no.	**Negative features**	**Relevance to target user**
1	Can not provide information about images	Not useful in recognizing images from real life.
2	Treatment tool; does not provide the names directly	Would not allow independent use
3	It is not free	Might not be affordable by all seniors
4	Only available on iPads	Some users might not have iPads

[23] https://constanttherapy.com last accessed on March 26, 2016.

4.2 Pattern Recognition Apps

4.2.1 TapTapSee

TapTapSee[24] is a mobile camera app designed specifically for blind and visually impaired iOS users. The app utilizes the iDevice's camera to photograph objects and the VoiceOver function to identify them aloud for the user.

Table 9: Review of TapTapSee

Sl no.	**Positive features**	**Relevance to target user**
1	Fast results given speed	Better than slow
2	Many social media sharing options	Good spreading ability
3	The ability to save images to the mobile devices	Helpful for relocating images
Sl no.	**Negative features**	**Relevance to target user**
1	There is no setting to turn "Voiceover" notification off	Interruptive
2	It is free only upto 100 photos	Might not be affordable by all seniors

4.2.2 VizWiz

VizWiz[25] is an iPhone app that allows blind users to receive quick answers to questions about their surroundings. VizWiz combines automatic image processing, anonymous web workers, and members

[24] http://www.taptapseeapp.com last accessed on March 26, 2016.

[25] http://www.vizwiz.org last accessed on March 26, 2016.

of the user's social network in order to collect fast and accurate answers to their questions.

Table 10: Review of VizViz

Sl no.	**Positive features**	**Relevance to target user**
1	Recordable questions	Helpful for tracking results
Sl no.	**Negative features**	**Relevance to target user**
1	Taken photos cannot be saved in the devices	Bad for relocating images, triggering memories and tracking results
2	Rarely gain answers	Might not be able to get results instantly, or even get one ever.
3	Icons are too similar	Hard for users to define the icons

4.2.3 Pongr

Pongr is not a tool available to the public. It is an image recognition technology that provides an alternative to QR codes or bar codes. Using this as a mobile photo marketing technology, the company[26] develops image recognition, artificial intelligence and direct response advertising tools to help brands and agencies monetize their consumer photos shared on the Web. The Pongr system processes customer-submitted photos as the entries in contests, sweepstakes and promotions. It also ties photo sharing on social networks to brand loyalty programs.

[26] https://www.linkedin.com/company/pongr-inc. last accessed on March 26, 2016.

Table 11: Review of Pongr

Sl no.	**Positive features**	**Relevance to target user**
Sl no.	**Negative features**	**Relevance to target user**
1	Only highly recognizable images are focused	Too limited
2	Only works for online pictures	Too limited
3	People centered pictures are not applicable	Need personal directory
4	Very expensive	Not affordable by seniors

4.2.4 Snaptell (Acquired by Amazon)

Until it was acquired by Amazon in 2009, SnapTell[27] was a free iPhone app that let users not only get instant reviews of a product, but also provided local and online price comparisons through TheFind[28], a personalized shopping search engine that was acquired by Facebook in 2015. SnapTell used a visual product search technology that let users take a photo of the cover of any CD, DVD, book, or video game, and automatically get information about the product and find ratings and pricing information online from Google, Amazon, eBay and more. The company has a database of about 5 million+ products.

[27] http://techcrunch.com/2008/11/19/snaptell-instant-product-lookup-from-the-iphone-you-want-this last accessed on March 26, 2016.
[28] http://techcrunch.com/2015/03/13/to-boost-commerce-in-ads-facebook-buys-and-shuts-down shopping-site-thefind last accessed on March 26, 2016.

Table 12: Review of Snaptell

Sl no.	**Positive features**	**Relevance to target user**
Sl no.	**Negative features**	**Relevance to target user**
1	Only barcode images are focused	Too limited
2	People centered pictures are not applicable	Not possible to recollect people names

4.3 Summary

From the review of various apps in this Section, the following design criteria emerged:

- Provide literal and verbal names for numbers
- Enable different levels
- Create vocabulary categories and items
- Provide built in cues for items, both audio and text
- Provide information about images
- Allow use of images from real life
- Make provision for built-in data collection
- Allow customizable content
- Allow clicking and saving photos on app or phone
- Allow adding text and audio descriptions for items
- Keep text easily readable and audio easily audible.
- Allow settings to turn off voiceover
- Design interaction interface accessible to seniors
- Keep the app free or charge an easily affordable price
- Make app available on all mobile devices
- Provide different language options
- Design to allow independent use

5 Vocabulary Development

5.1 Introduction to vocabulary

Vocabulary is a set of core words that dominate our everyday speech. Stuart & Beukelman (1997) found that 174 words made up 72 percent of what seniors said across all environments and topics, and 250 words made up 78 percent of what they said, even including shopping trips and telephone conversations. And these include not just nouns but all words. This implies that for a person of limited speech such as my anomic grandfather, the total vocabulary of noun words might comfortably be within 100 or much less. Generating the vocabulary is a systematic process of identifying the most useful words and arranging them in a hierarchy. The hierarchical arrangement helps in creating categories within which items can be placed. For example, 'fruit' would be a category under which 'mango', 'apple' and 'banana' would be placed.

The vocabulary for the iRemember database was generated based on consultations I had with a Speech-Language Pathologist (SLP), whose clients are primarily Chinese aphasia patients in Great Toronto Area (GTA), and my personal experience with my grandfather. Through interactive analysis between these two sets of data, a vocabulary was derived to assist anomic aphasia patients to

communicate with their family members during activities of daily life (ADL).

5.2 About Anna Wong, SLP

Anna Victoria Wong[29], is the Speech Language Therapist I consulted as an expert in Toronto working with Chinese aphasia patients. She possesses an impressive string of educational and professional credentials: ABC, B.A. Hons, B.Sc. B.Ed., MBA, MCD, CHE, Reg. CASLPO.

Anna is a doctoral candidate in Speech-Language Pathology and a learning disability strategist. Proficient in English, Cantonese, Mandarin, and French, Anna provides speech-language and swallowing therapy for children, youth, and adults for articulation, stuttering, language development, and swallowing issues. Anna proactively engages caregivers in the therapy process to optimize the results of treatment.

Certified as Speech-Language Pathologist in both Canada and the United States, Anna is involved in leading-edge research in conjunction with a number of universities in North America, to improve

[29] http://www.annavwong.com/clinical-experience.html, http://www.speechassociates.ca/aboutus.php

the quality of speech-language rehabilitation techniques. Anna is also the winner of Communicative Access Award from Aphasia Institute, for making self-help Aphasia educational resources available to the Chinese community.

A Certified Health Executive and Adult Educator, Anna delivers seminars and presentations to families and organizations across the GTA for speech, language, and swallowing education and risk prevention. Prior to becoming Speech-Language Pathologist, Anna has years of experience helping immigrant families settle into the local education system and employment market, teaching language classes, and helping executives with public speaking and accent reduction.

Anna is certified in MBSImp and FEES for the diagnostic needs of swallowing patients, LSVT for voice patients, Supportive Conversation for Aphasia patients, and deploys Hanen and PROMPT techniques to facilitate language and speech development for children. Anna provides speech therapy for adults and children across the Greater Toronto Area.

5.3 Vocabulary Generation

Anna showed great interest in this project. She said that the idea of the iRemember app appeared promising, exciting and

potentially helpful to the Mandarin speaking community, given that there is no such app presently. Through consultation with her, I finalized a list of most common as well as important categories that should definitely be included in the vocabulary database:

1. Critical care
2. Mood scale
3. Pain scale
4. Social settings
5. Home settings
6. Hospital settings
7. Family settings
8. Religious settings
9. Nouns, verbs, adjectives
10. Time/date

Using the above category list, I organized a vocabulary list as shown in Table 1 based on my experience with my grandfather and other Chinese elders.

Table 13: Vocabulary database table

Vocabulary Database
Mood Scale with levels
(Definitely do not feel) (Do not feel) (Slightly feel) (Definitely feel)

XX	X	V	VV

According to Brief Mood Introspection Scale (BMIS) by John D. Mayer

Lively	XX X V VV	Drowsy	XX X V VV
Happy	XX X V VV	Grouchy	XX X V VV
Sad	XX X V VV	Peppy	XX X V VV
Tired	XX X V VV	Nervous	XX X V VV
Caring	XX X V VV	Calm	XX X V VV
Content	XX X V VV	Loving	XX X V VV
Gloomy	XX X V VV	Fed up	XX X V VV
Jittery	XX X V VV	Active	XX X V VV

Pain Scale

According to The Numeric Rating Scale (NRS-11)

0	No Pain
1-3	Mild Pain (Nagging, annoying, interfering little with ADLs)
4-6	Moderate Pain (Interferes significantly with ADLs)
7-10	Severe Pain (Disabling; unable to perform ADLs)

Social settings			
Eating	Shopping	Playing	Visit Clinic

Household Items:								
Kitchen								
Fork	Spoon	Plate	Pan	Pot	Oven	Fridge	Microwave	Mug
Cup	Cloths	Spatula	Cabinet	Bowl	Knife			
Chopsticks	Pantry							
Food								
Fruit	Meat	Vegetable	Water	Beer	Wine			
Rice	Potatoes	Juice	Soup	Milk				
Bathroom								
Sink	Mirror	Towel	Toilet	Shampoo	Soap	Toilet Paper		
Bathtub								
Living room								
Couch	Table	Plants	Computer	Clock	Curtain	TV	Pen	
Stereo	Book	Lamp	Pencil	Chair				
Storage room								
Broom	Mop	Vacuum	Garbage					
Bedroom								
Bed	Quilt	Pillow	Cushion	Sheets	Hanger	Shoes		
Throw	Cloths							

Family Settings (Customizable)			
Parents	Spouse	Children	Relatives
Grandchildren	Grandparents	Cousins	Nanny

Colors

Red	Blue	Green	Yellow	Black	White	Orange	Purple
Gold		Silver		Copper		Brown	
Numbers							
0	1	2	3	4	5	6	7	8	9
10	100	1,000	10,000	%	$		
Time (Chinese way)							
X o'clock X minutes							
Date							
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday		
Sunday	January	February	March	April	May		
June	July	August	September	October			
November	December						
Religious Setting (Buddhism+Christian)							
Buddha	Statue	Candle	Candlestick	Tribute			
Cross	Beads	Bible					

5.4 Summary

This vocabulary is not the end. The app will provide an option to add more categories as well as items under each category. The vocabulary, and the design criteria generated in the previous Sections are moved forward in the next sections into the design of the prototype app *iRemember*.

6 Design of the iRemember App

This section begins with the visualization of the information architecture of the iRemember App in the form of a flowchart (Section 6.1). This is followed by a description of each of the components of the flowchart (Section 6.2) and 16 screen mockups (Section 6.3) to illustrate some of the important components that could be a part of the first iteration of the iRemember mobile App.

6.1 Visual flow of the Design Prototype

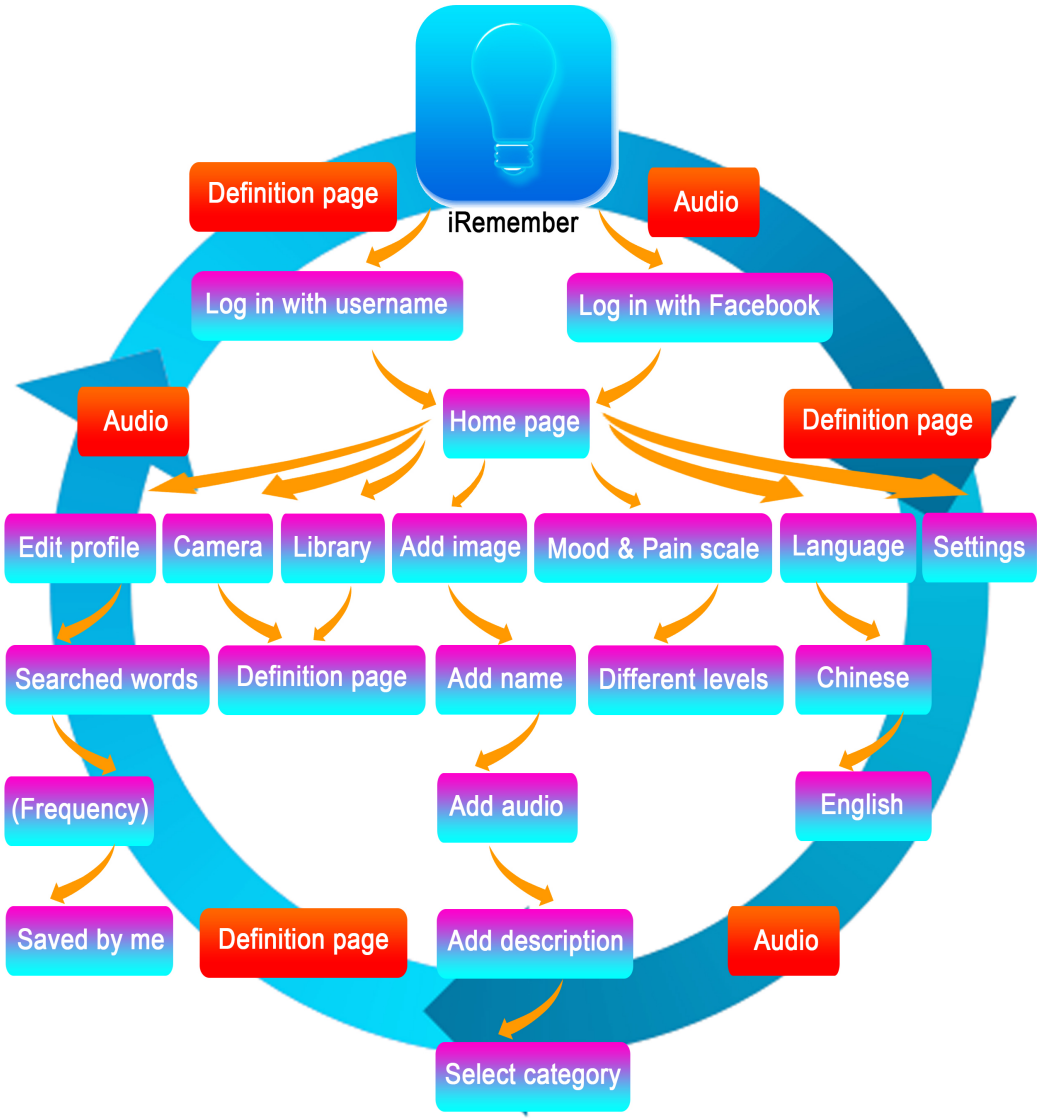

Figure 2: iRemember App Flowchart

6.2 Technical Aspects

Two important technologies that drive the iRemember app are Pattern recognition and Image retrieval which were discussed earlier in Sections 4.2 and 4.3 respectively. The level and tempo of development of these two technologies had been rather low until a decade ago, when use of mobile devices, computers and the Internet, became popular. Since then, the importance and the popularity of these technologies have multiplied. More and more businesses and app developers have stepped into these fields. In the following sections, the application of these two technologies in the *iRemember* app is described.

6.2.1 Pattern Recognition

Psychologically, pattern recognition describes a cognitive process that matches information from a stimulus with information retrieved from memory. Specifically, the recognized patterns can be those perceived in facial features, units of music, components of language or characters and other symbols. At this point, it would be clear that this is an academic description of how one normally remembers things, saying, " Oh… this is what this thing is called". For example, you remember how your primary school classmates looked like when you are in your 60's, you know how a pig looks like; you

know how a pencil looks like. Because you have seen these things, the patterns are stored in your brain and match within your brain when the mind brings up a reference.

The above paragraph explained what pattern recognition actually is, psychologically and literally. From a machine perspective, pattern recognition is a branch of machine learning that focuses on the recognition of patterns and regularities in data. It is generally categorized according to the type of learning procedure use to generate the output value. This is precisely what the technology Tineye is applying and what is needed in the app as well. Picture recognition is also used in computer-aided diagnostic systems, speech recognition, automatic recognition of handwritten postal codes, optical character recognition and so on. And, of course, the modern camera is one of them as well.

The main background operation in the App is matching images from the database. I am sure employing pattern-matching technology will enable the App to function effectively.

6.2.2 Image Retrieval

An image retrieval system is a computerized system for browsing, searching and retrieving images from a large database of digital images. Most traditional and common methods of image retrieval

utilize some technique of adding metadata such as captions, keywords, or descriptions to the images so that retrieval can be performed over the annotation words. Additionally, the increases in social web applications and the semantic web have inspired the development of several web-based image annotation tools.

The first microcomputer-based image retrieval database system was developed at MIT, in the 1990s, by Banireddy Prasaad, Amar Gupta, Hoo-min Toong, and Stuart Madnick. Several small image retrieval web applications were developed rapidly in the past two decades. A personal experience of the speed became evident when I saw "Tineye.com"[30] being launched within a year of my toying with the idea of designing an image reverse search engine. These apps, however, are not very helpful because the level of accuracy required is very high. For example, Tineye.com, the biggest image retrieval web in the market, returned the result "0 Results, Searched over 14.146 billion images" for the search of a photo of a rose. This shows that no matter how many images the database contains, a high degree of accuracy is still hard to achieve.

[30] Tineye is a Toronto-based company specializing in large-scale image search and recognition technology. https://www.tineye.com last accessed on March 25, 2016.

I put together an image database for the vocabulary, which includes comprehensive angles of all items. And the number of the items does not even exceed 100. It appears that it would be possible to apply this amazing technology to the *iRemember* app to achieve good results.

6.3 Description of the Prototype App

There are 4 main modules in the iRemember App: Camera, Library, Add images, and Mood & Pain scales. The last two modules contain subordinate modules, which are visible upon opening them. Users can either register with their own email or sign in through their Facebook credentials. Chinese and English language options are available. Controls for displaying text definition and playing audio description are available on all screens. Every image is associated with a text and audio description. iRemember is devoted to improving every feature to offer users the best experience.

6.3.1 Audio Description

This function provides the user with a spoken version of the name of the image selected or retrieved through search. It uses the built-in text-to-speech tool native to the phone platform, such as VoiceOver on iOS and TalkBack on Android. This feature would be useful to those

with vision impairments. Notwithstanding the synthetic voice, this function provides users a clear and precise auditory description.

6.3.2 Word definitions

This function is for anomia users to get a better sense what any word actually means, so that they get more than to know just the name. According to the SLP, Dr. Anna Wong, accompanying a word with its definition or a description might help the patients to memorize or get familiar with the word better.

6.3.3 User Profile

This section gives the users a sense of belonging and creates a better connection between the users and the App. Users can add their nickname, profile picture and say something about themselves.

6.3.4 Word Search

The *Searched words* button is under *Edit profile* section. Users can go there and find which words they have searched before and *how frequently* they have searched the same word. This function basically keeps the users, the users family and researchers on track.

6.3.5 Saved by Me

The *Edit profile* section also contains a *Saved by me* button. Since this App allows users to create and upload their own "visual-vocabulary" into the database, they should be able to locate those images as such. If the users added some words, it would mean that those words are common for them. Therefore, this function is a shortcut for them to find their own common words. Also, it creates a sense of self-esteem and confidence in them to view and use data that was created by them.

6.3.6 Camera

The *Edit profile* section provides a camera function for the users to take pictures instantly and search the database using that picture. If there is a match, the definition page will be retrieved and displayed/announced.

6.3.7 Library

This option provides the function for users to choose the images they already have in the mobile device. If there is a match, the definition page will be retrieved and displayed/announced.

6.3.8 Add Image

This section allows users to create text and audio descriptions for images of things that they think are very useful for them but are not in the database, and upload them.

6.3.9 Add Name

This section allows users to add a textual name for the image the user wants to add to the database.

6.3.10 Add Description

This section allows users to add the audio description of the picture and of the word the user wants to create.

6.3.11 Select Category

This section allows the database to easily organize the words under meaningful categories.

6.3.12 Mood and Pain Scale

This is an assistive section, or a bonus section. It has a clearly indicated scaled diagram of different levels of various emotions and pain. Users can tell people what they feel and how they feel by simply pointing their fingers on the right spot on the screen.

6.4 Screen mockups

Figure 3 through 19 present the 16 screens that were designed as part of the iRemember prototype mobile App. As can be seen, not all of the screens envisioned in the visual flow chart presented in Figure 2 were designed, but only some representative samples as a proof of concept.

Figure 3: iRemember icon

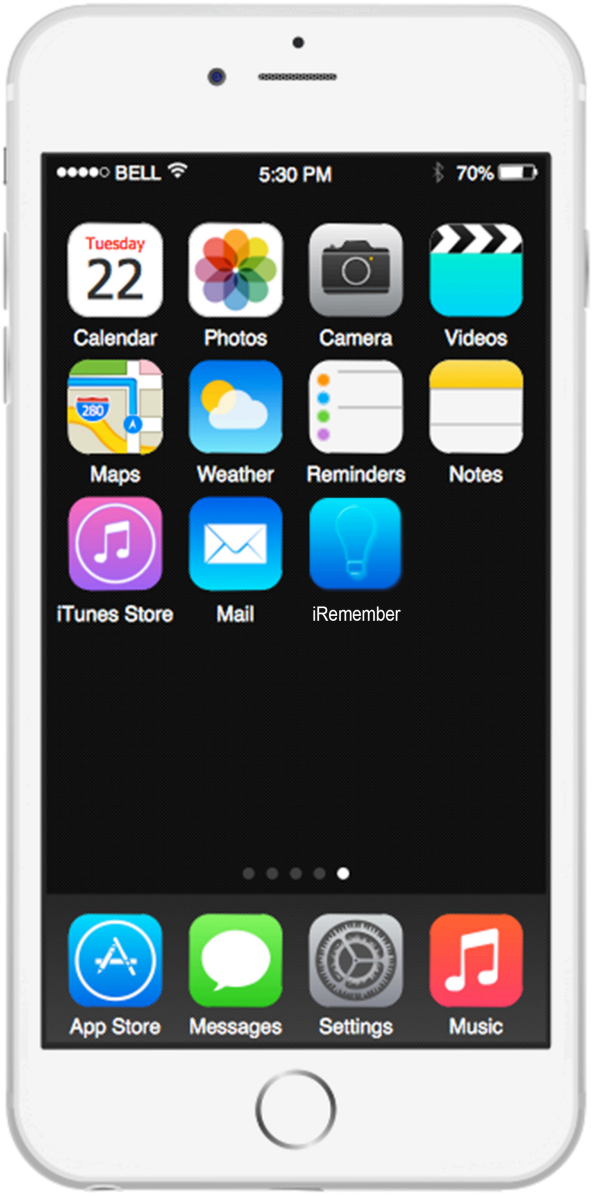

Figure 4: iRemember icon on phone screen

This screen shows the iRemember application icon as it would appear on the home screen of any mobile phone.

Figure 5: iRemember home page

This is the home page of the iRemember mobile App. It shows a transparent light bulb in the middle with blue, cyan and magenta gradient background.

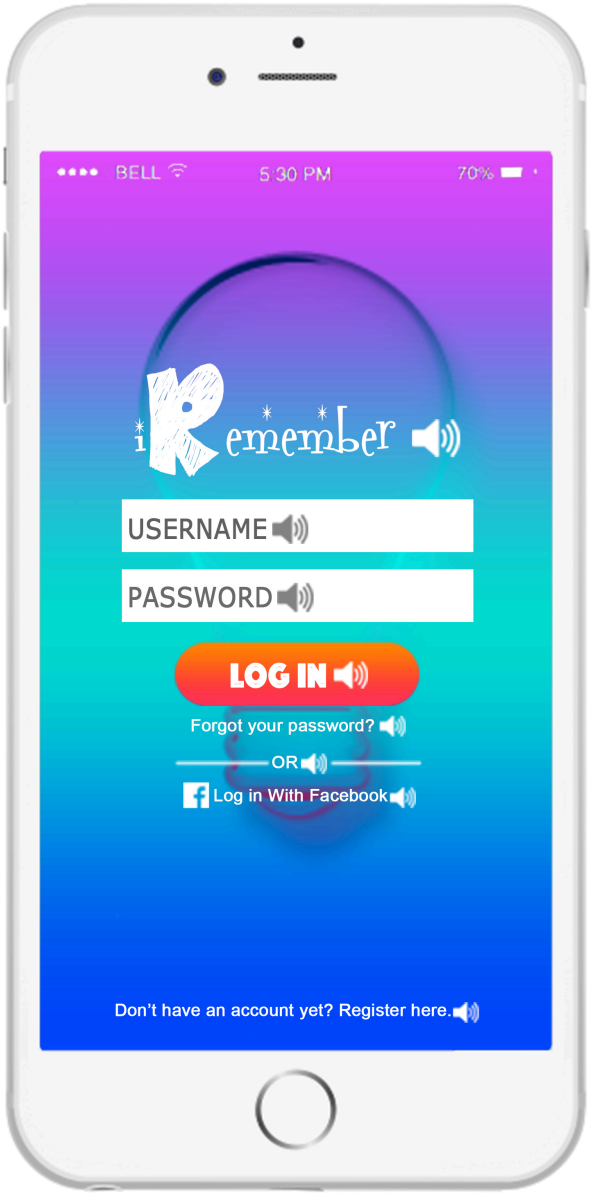

Figure 6: iRemember log in screen

This screen allows the user to sign into the secure data area of the underlying information system to gain access to their searched history and saved data.

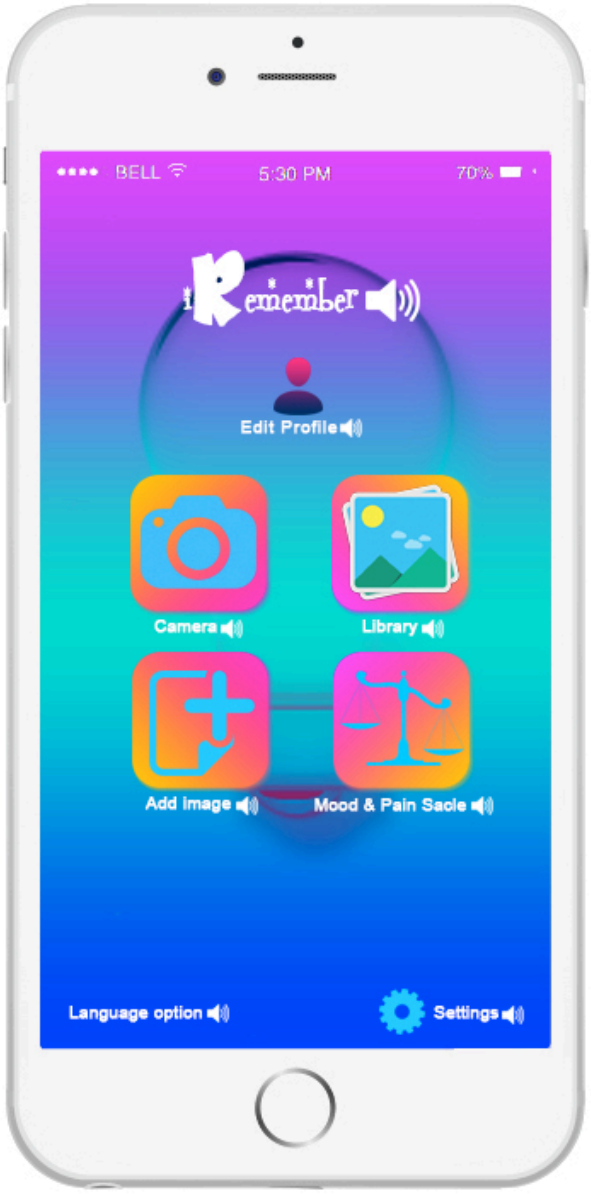

Figure 7: iRemember main menu

The main menu of the iRemember App along with "Edit profile", "Language option" and "Settings", are displayed on this screen.

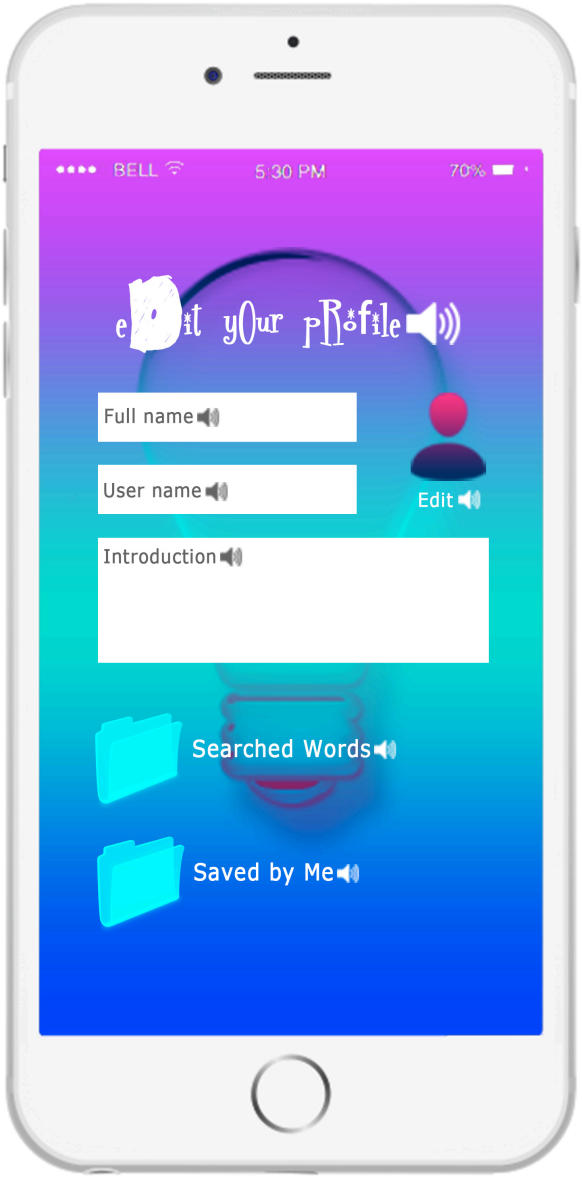

Figure 8: iRemember edit profile page

The "Edit profile" page with "Adding profile picture", "Full name", "Nick name" and "Introduction" is displayed on this screen along with "Searched words" and "Saved by me" sections.

Figure 9: iRemember searched words page

The searched words page of the iRemember App with item images and frequency, is displayed on this screen.

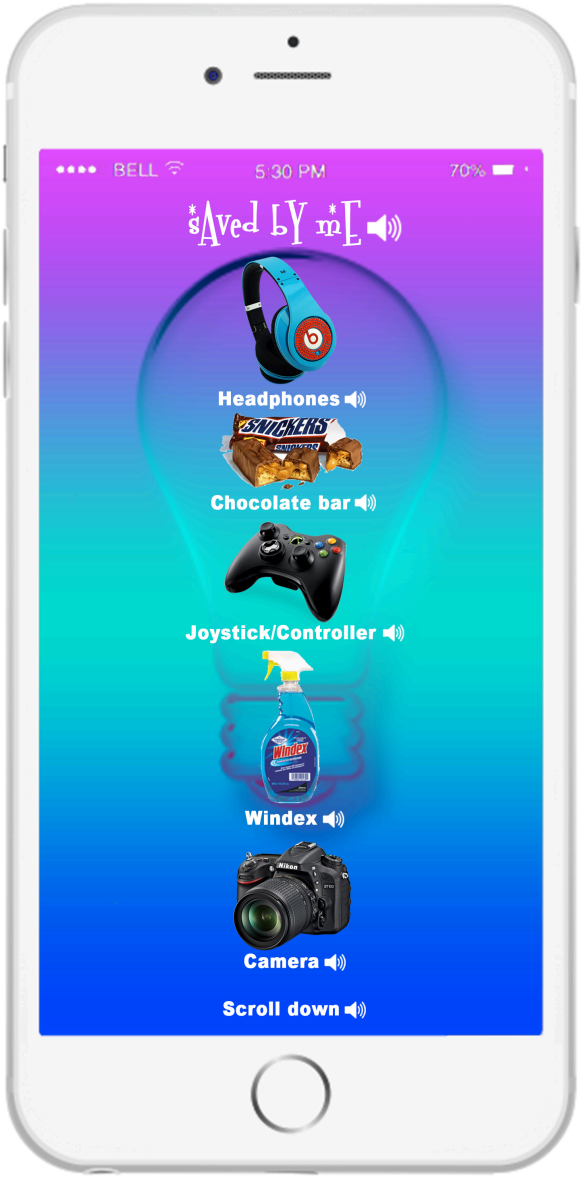

Figure 10: iRemember "Saved by me" page

The "Saved by me" page of the iRemember App with item images and names, is displayed on this screen.

Figure 11: iRemember photo taking page

The camera page of the iRemember App, is displayed on this screen.

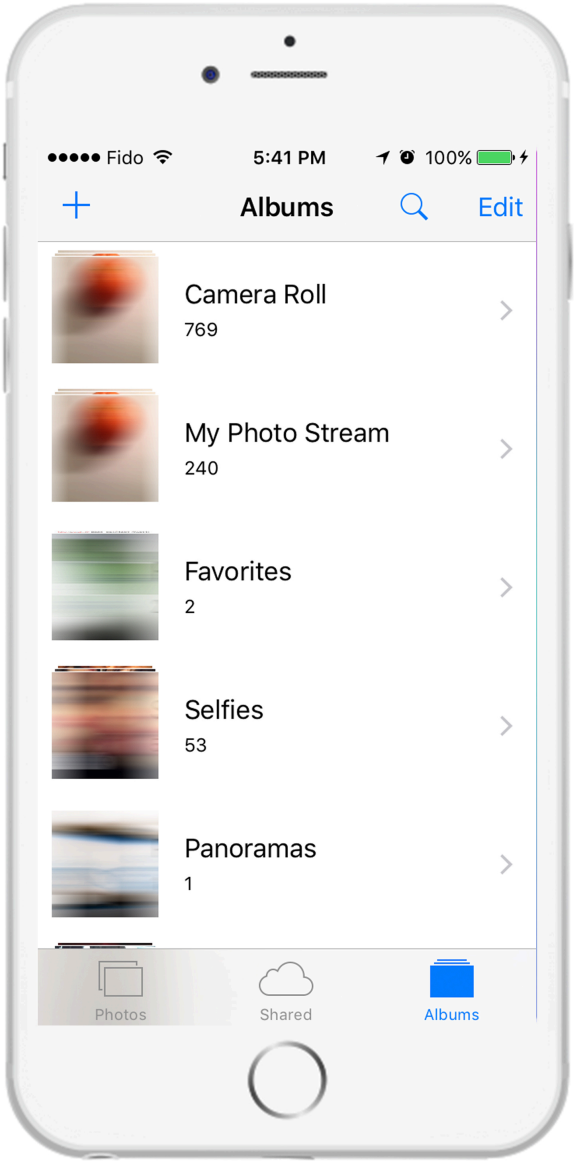

Figure 12: iRemember library page

By choosing existing pictures in the mobile device, users will be able to retrieve any photo they took long time ago. This feature gives the App flexibility that users could either take pictures or select from database.

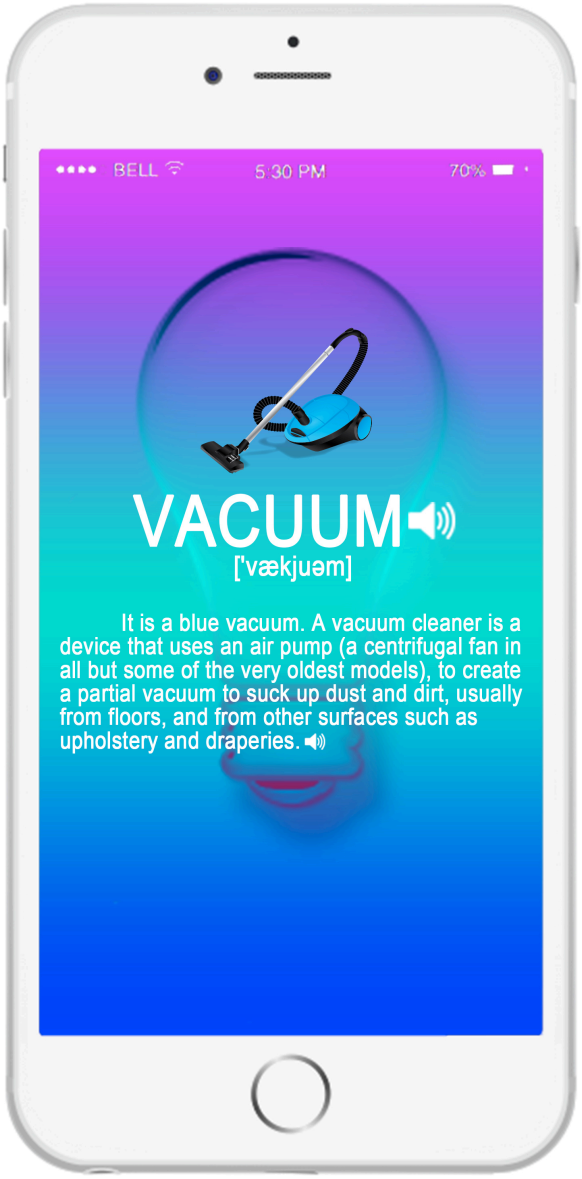

Figure 13: iRemember definition page

This screen shows the appearance, name, phonetic symbol and description of the word “Vacuum”.

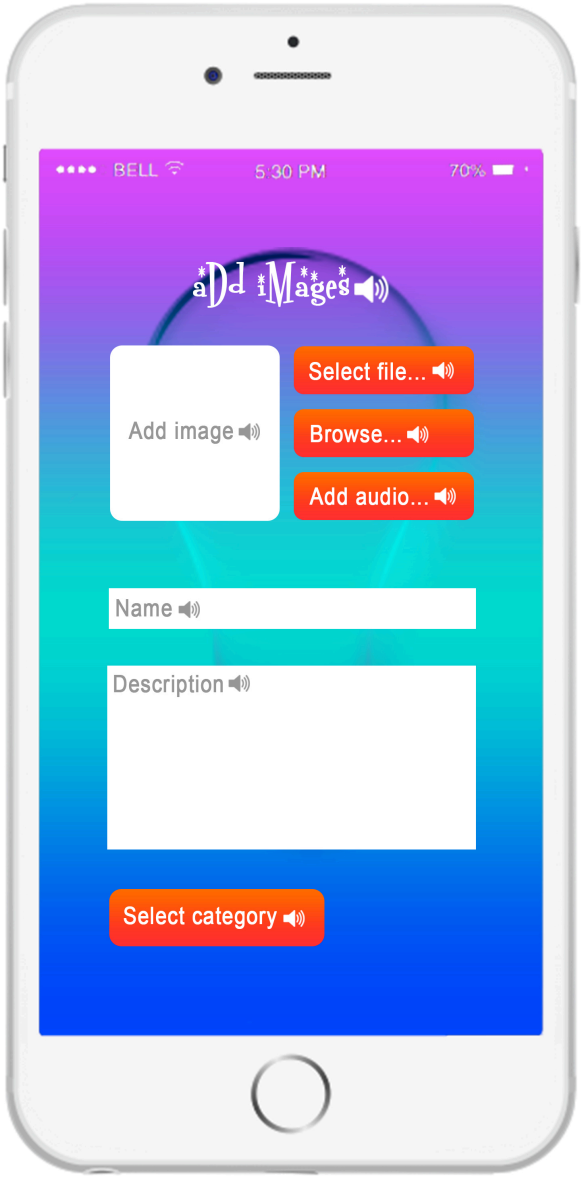

Figure 14: iRemember create word page

This screen shows the "Add image" page of iRemember mobile App with "Adding image", "Adding name", "Adding description", "Adding audio" and "Select category" sections.

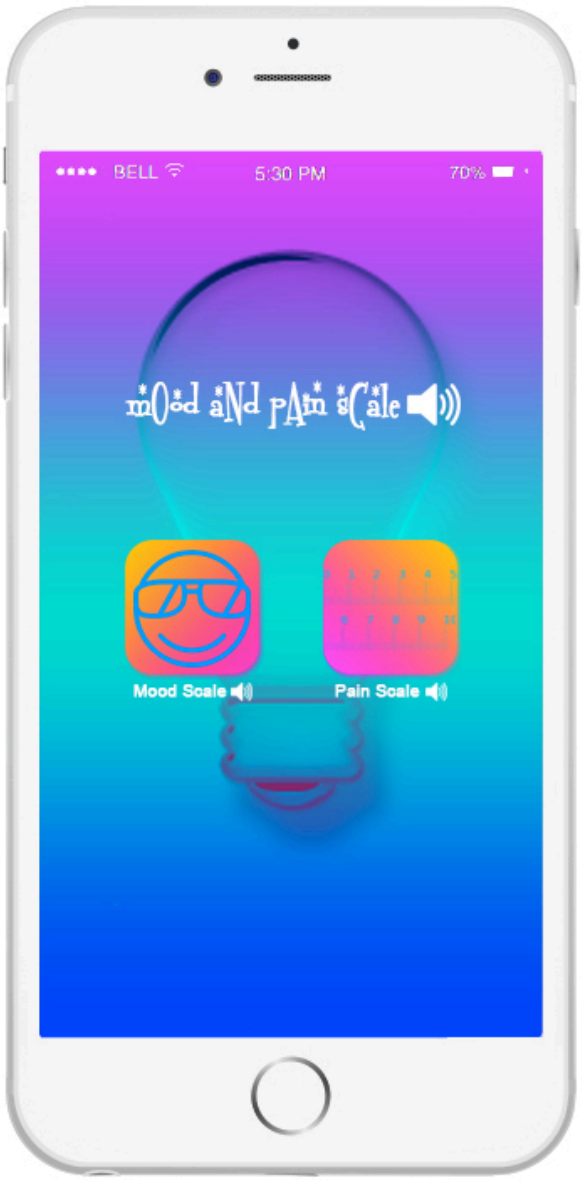

Figure 15: Mood & Pain scale page

This screen shows the starting page of the mood and pain scale section of iRemember mobile App.

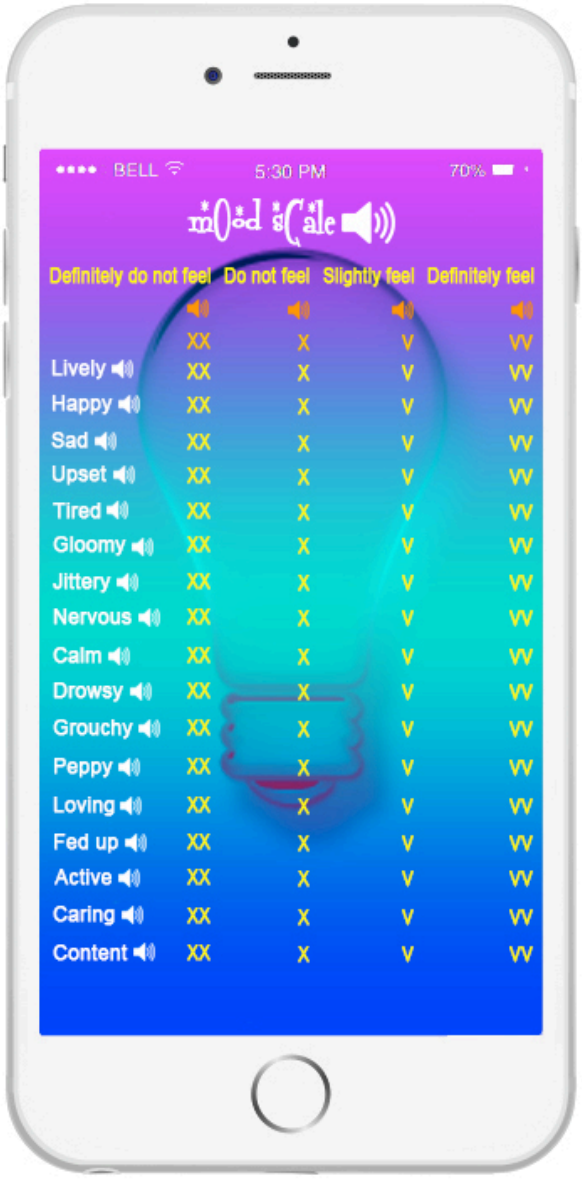

Figure 16: iRemember mood scale page

This screen shows 17 most common emotion words with 4 different levels. This feature enables users to "visualize" and indicate their mood to other people.

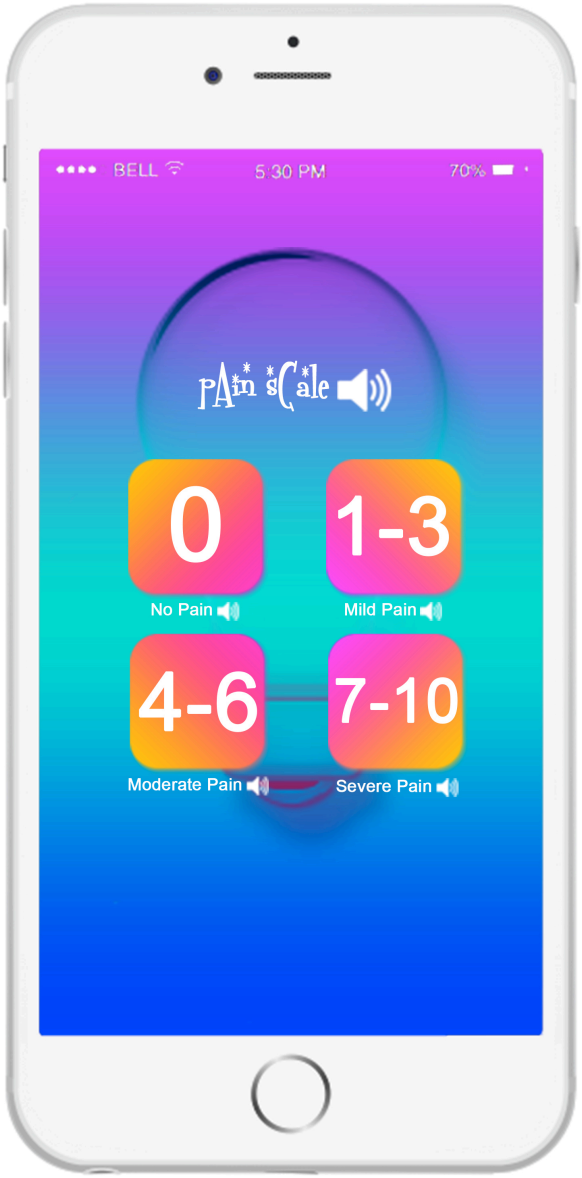

Figure 17: iRemember pain scale page

This screen shows 4 different levels of general human body pain. This feature enables users to "visualize" and indicate their pain to other people.

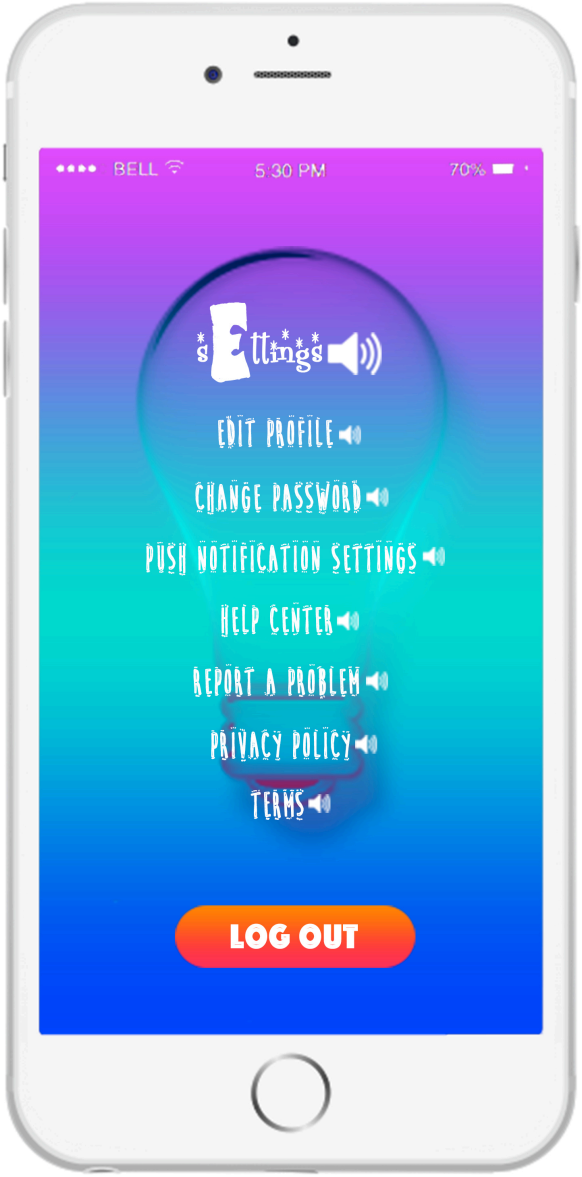

Figure 18: iRemember setting page

This screen shows the settings page of iRemember mobile App with 8 items.

6.5 Summary

This section provided an overview of the design of the iRemember mobile app. Beginning with the visualization of the information architecture of the iRemember App in the form of a flowchart in Section 6.1, a description of each of the components of the flowchart was provided in Section 6.2, followed by 16 screen mockup presented in Section 6.3 to illustrate some of the important components that could be a part of the first iteration of the iRemember mobile App.

7 Discussion

As was apparent from the literature review presented in Section 2, even though it might be easy to understand the word-finding problem that anomia patients face, finding a cure or even a way to improve their living experience is not that easy. At the same time, the environmental scan of popular apps for aphasia in Section 4 revealed that therapy apps provide a useful way of attempting to make their lives easier. However, most of these apps are not free, and they primarily cater to English, Spanish or French speaking users.

Profiling a Mandarin-speaking Chinese elder anomia patient in Section 3 based on my lived experience with my grandfather and deriving design requirements through exploration of popular apps in Section 4 in the context of that user, I derived a vocabulary specific to daily life in a Chinese cultural context in consultation with a Speech-Language Pathologist working with Chinese anomia patients. Based on this, I developed the design for a prototype assistive naming mobile app called *iRemember* in Mandarin and English for Mandarin speaking anomia patients.

The iRemember app is conceived to be used by the patient independently to perform word-finding. Such independent functioning is expected to provide a sense of agency to the patient and make them

feel empowered. It could avoid the embarrassment that might result from dependence on another person. Four main features of the app are exemplified below through use case scenarios.

7.1 Use Case Scenarios

7.1.1 Picture Capturing

***Feature 1**:*

Using the app's picture capturing function, the user could take pictures of items (say, of a fork, an orange, a laptop, a broom, a family member, and such) and use it to search the database for its description through pattern recognition and image retrieval from the database.

Scenario 1:

Zhongfa had a visitor, who brought him a cake. Zhongfa wanted to thank him, but could not remember the name 'cake' even though he knew that he is supposed to cut and eat it. When the visitor was talking with another family member, Zhongfa quietly removed his mobile phone, turned on the camera through the iRemember app and took a picture of the cake. The app quickly searched its database with the image, found the word for that image and displayed it. Zhongfa said in a loud, confident tone to the visitor, "Thank you very much for the cake!" He felt very proud of himself.

7.1.2 Selecting from Available Images

***Feature 2**:*

Users can access words in text and audio by selecting any picture from the images available in the app database.

Scenario 2:

It was a family get-together day in Zhongfa's house. Several members of the extended family were enjoying good food and having fun conversations. Zhongfa's three-year old great grandson came running and sat on his lap. Zhongfa wanted to call out his name and talk with him. But try as he did, he couldn't remember the child's name. Quickly, he turned on the iRemember app on his mobile phone and went to the section where all family members headshots had been stored along with the names. He found the child's picture, and read his name. Then he could call the child by his name and fondly talk with him. His eyes filled up with emotion recollecting how he used to suffer previously when he was not able to remember names of people.

7.1.3 Adding Images, Names, Text and Audio Descriptions

Feature 3:

Both users and caregivers can add images, names, and descriptions (both text and audio) into the database. This

involves taking pictures properly, adding the descriptions in audio and/or text accurately, and saving it properly.

Scenario 3:

Zhongfa's grandson Zimmo had come home for vacation. He was a graduate student in a foreign university. Zimmo was very impressed with the *iRemember* app. He wanted to help his grandfather, whom he loved very much. Through association with his grandfather, Zimmo knew which items around the house his grandfather usually uses or wants to refer to. When his grandfather was resting in the afternoon, Zimmo quietly picked him his phone and went around the house taking clear pictures of those items through the app. The app had a very easy interface that allowed him to upload the image and also to add a text description and an audio description for each of the images. Grandfather was pleasantly surprised to find the additional words in the vocabulary under 'new words added'. Zimmo felt happy to see his grandfather happy.

7.1.4 Mood and Pain Scales

Feature 4:

The app provides a mood scale chart and pain scale chart, using which users can pinpoint their mood and pain level.

Scenario 4:

At one point, Zhongfa had a throat infection that prevented him from being able to talk. He was very upset and grumpy with pain. His wife was unable to figure out why. Then she remembered his iRemember app. She quickly removed his mobile phone, turned on the app and handed it to him. Zhongfa immediately went to the 'pain scale' menu item, touched 7-10 and pointed to his neck. He also brought up the mood scale and pointed out his mood as 'tired'. His wife promptly gave him a pain reliever to eat and got him to rest. The app truly saved the day for Zhongfa.

7.2 Summary

The above use case scenarios illustrate features of the app that help an anomic, Mandarin-speaking person live with a greater sense of agency over their life and daily activities.

8 Conclusion

8.1 Contributions

This project was an inclusive design exercise that attempted to stretch the design of popular anomia mobile apps for assisted word finding through the conceptualization of the iRemember mobile app, which caters to the unique language and cultural requirements of Mandarin-speaking Chinese anomia patients. Thus it encompasses greater diversity.

This app will be especially useful to bilingual patients who spoke Mandarin as well as English before the onset of aphasia and lost one or both the languages. In these cases, when they need to move between the two languages often, such as with a Mandarin speaking person living in Toronto, deciding what a word mush be would be especially confusing because code switching becomes difficult.

Further, the app also stresses reclaiming of agency by the users over their activities of daily life and engagement with others. Development and use of this app could, potentially, draw the attention of developers and businesses to the benefits of focusing on language and culture as important aspects for expanding usage/sales of such software tools. This could lead to a broader impact of this design.

Inclusive Design advances accessibility and encompasses the "full range of human diversity including ability, language, culture, gender and age"[31]. To be truly inclusive, design must be usable, flexible, and customizable among other things. iRemember is designed to be easy to use; it has multiple functions; and it allows the user to modify the database to suit their unique needs.

I conceived this tool not as a cure for the disease, but to reduce all the unnecessary stress of anomic aphasia patients. While *iRemember* is a Mandarin-focused app, it includes English and so its functions could still assist or be applied to English speaking patients. As an inclusive designer, while creating the design of the iRemember mobile App, I tried to remain aware of the context and broader impact of my design on all Mandarin speaking anomia individual or even all the anomia patients.

8.2 Limitations and Future Work

User requirements for the design of iRemember were derived primarily based on my own experience and consultations with a Speech Language Pathologist, backed by evidence from previous research studies and relevant anomia therapy Apps. This approach could be biased by personal views about Mandarin speaking anomia

[31] http://idrc.ocadu.ca/component/content/article/48-library-of-papers/443-whatisinclusivedesign last accessed on March 25 2016.

patients, even though I consider my views to be socially constructed, and, therefore, reflecting a general perspective. To counter such bias, prototype evaluation studies will be conducted with representative users. The next steps will, therefore, be to iteratively and inclusively refine and develop the prototype though testing with Mandarin speaking anomia patients.

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